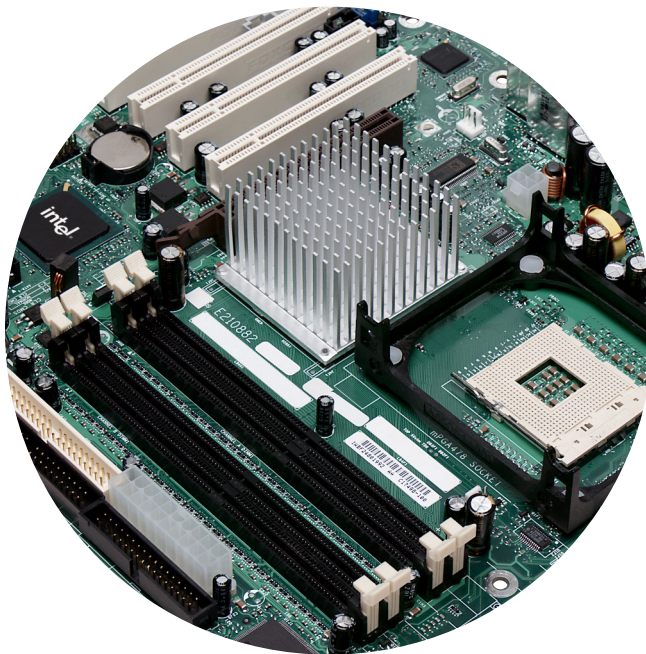




Can Dual Channel DDR400 memory balance the performance of the Intel® Pentium® 4 processor with 800 MHz front side bus?



**Yes. Dual Channel DDR400 delivers
an access path to system memory
at a throughput that is equal to
the 800 MHz front side bus on the
Intel® Pentium® 4 Processor with
Hyper-Threading Technology¹ for
optimal platform performance.**



Fast access to system memory is vital for the overall performance of the platform. On systems where the FSB and system memory bandwidth are not equal, certain memory-intensive applications are forced to “wait” while the system negotiates the “bandwidth bottlenecks,” resulting in slower performance.

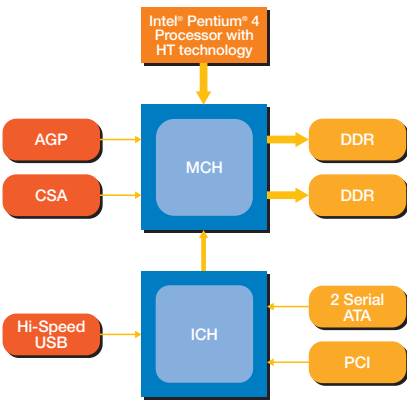


Figure 1: Platform Memory Access—the Importance of System Memory

Dual channel DDR memory unleashes the full power of the Intel® Pentium® 4 processor with 800 MHz Front Side Bus (FSB) by matching the processor FSB bandwidth of 6.4 MB/s with an equal, balanced 6.4 MB/s of memory bandwidth.

In combination with the CPU and chipset, system memory is one of the key contributors to overall platform performance. Nearly every application and component, whether internal or external, accesses the system memory through the Memory Controller Hub (MCH), shown in Figure 1.

The CPU initiates the heaviest access to and from system memory. Every application processed by the CPU is first transferred to the system memory through the MCH and then to the CPU's local memory (known as Cache) for execution. Because the CPU uses the system memory for temporary storage of application instructions, and computation results, having a fast access to system memory by CPU and the rest of the platform will have a direct positive impact on the performance of application and improves the response of the platform.

Why Dual Channel DDR Memory?

Dual Channel DDR400 is the highest performing PC platform memory architecture available in the market today. Intel designed the 875P, 865G, and 865PE chipsets to take full advantage of this new memory architecture by developing a dual channel memory interface on MCH that is optimized to be used by Pentium 800MHz FSB. With up to 6.4MB/s data transfer rates capability, Dual Channel DDR400 memory architecture balances the bandwidth capability of Intel Pentium 4 with 800 MHz FSB. The result is a balanced platform that optimizes for memory demanding applications such as 3D graphics in advanced games, 3D modeling, high resolution video editing and playback in addition to other multi application and multi tasking applications

Balanced Platform Benefits

There are many reasons why faster system memory will improve platform performance overall. Figure 2 illustrates the benefits of Dual Channel DDR400 and the balanced platform performance for 3D applications and high-resolution video graphics display, as configured with the Intel Pentium 4 processor with 800 MHz FSB and an AGP 8X graphics

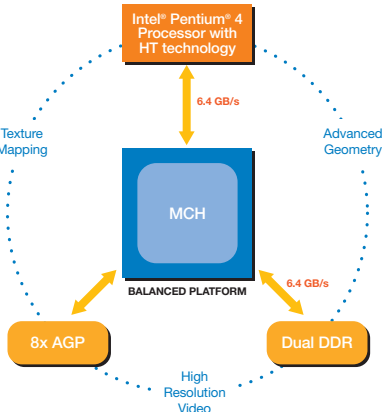


Figure 2: Advantage of Balanced Platform

engine. The AGP graphics engine shares a portion of system memory for geometry, advanced textures, frame buffer and other graphics related activities. As users interact with 3D objects, the CPU quickly access the system memory, transfers the geometry data to its local memory and starts the computation of creating the new geometry data.

The new geometry data is then placed back into system memory for the AGP graphics engine to access. Having a high bandwidth, fast access to system memory from CPU and the AGP graphics engine becomes an important factor for high performing games and 3D modeling applications. Additionally, the AGP graphics engine uses a portion of system memory as its frame buffer memory for high resolution video editing and playback. Because dual

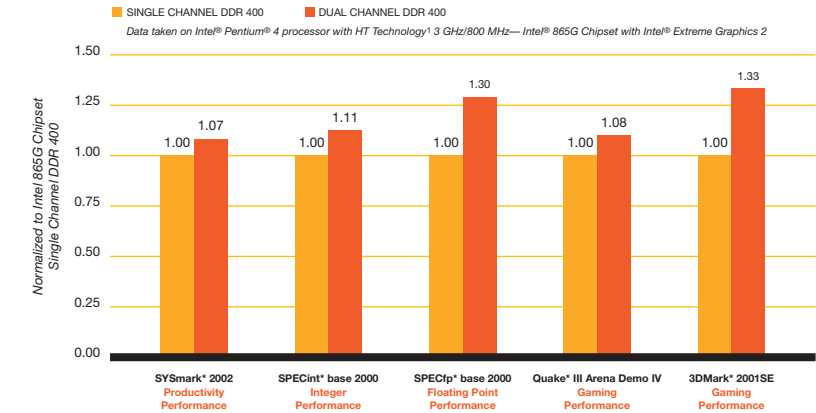


Figure 3: Advantage of Dual vs. Single Channel DDR Memory

Benchmark Configuration
Source: Intel® Configuration: Intel® Pentium® 4 processor with HT Technology at 3 GHz/800 FSB and Intel® 865G Chipset—Intel® 865G Desktop Board, 512 MB DDR400; All Platforms—Integrated graphics with Intel® Extreme Graphics 2, Graphics Driver 6.13.01.3485, Microsoft® Default UDMA-5, Intel® Chipset Software Installation Utility 5.00.1012, IBM® 80GB 120GXP IC35L080AVVA07-0 ATA-100 Hard Drive; Intel® C & FORTRAN compilers 7.0 for SPEC, DirectX® 8.1, Windows® XP Build 2600 SP1, 100 Mbps Intel® Pro/100+ Management PCI LAN Card. Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel® products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

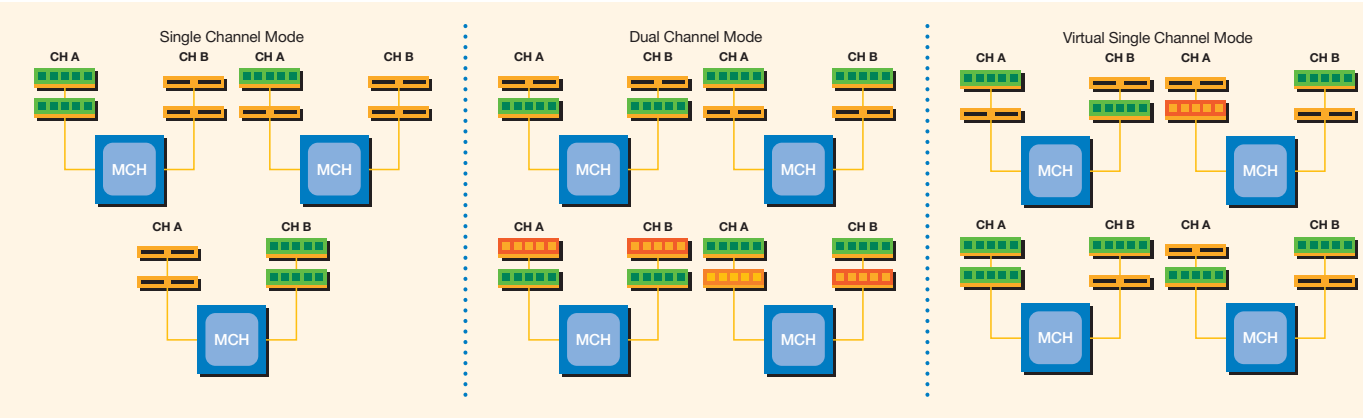


Figure 4: Memory Configuration Flexibility with Dual Channel DDR

channel DDR memory provides faster access to main memory, users benefit from improved frame rates and the smooth quality of high-resolution motion video playback.

Flexible Memory Configurations

Intel 875P, 865G, and 865PE chipsets support single and dual channel DDR400 and/or DDR333 memory configurations, as illustrated in Figure 4. DDR400, DDR333, or a mix of these memory speed DIMMs offers maximum flexibility in system manufacturing and configuration.

The MCH Intelligent Memory Manager in the Intel 875P, 865G, and 865PE chipsets automatically identifies the speed and placement of the DDR DIMMs, and applies the appropriate memory frequency and speed depending on the type and placement of the memory DIMM modules. This flexibility allows the system manufacturers and consumers to fully or partly populate system memory at the time of system purchase, and then upgrade the platform to take greater advantage of the Dual Channel DDR400 bandwidth later, for more demanding applications.

The Intel® Chipset Dual Channel DDR Support

The Intel 875P, 865G, and 865PE chipsets are the first chipsets on the market to support dual channel DDR for Intel Pentium 4 processors.

The 875P chipset was introduced for the performance and entry-level workstation markets. Featuring Intel® Performance Acceleration Technology (PAT), the 875P chipset provides increased memory access performance when used with the Intel Pentium 4 processor with 800MHz FSB and dual channel DDR400 memory. With the introduction of 865G and 865PE chipsets, Intel brings the performance of dual channel DDR to mainstream corporate and consumer markets.

The Intel Advantage

Importance of Memory Controller Hub (MCH) Design

Signal Quality and Integrity
Support for dual channel DDR memory resides inside the MCH in the Intel 875P, 865G and 865PE chipsets. Due to the extremely tight signal timing and the support for standard 4 layer circuit boards, more complex memory controllers are required to realize the memory performance of dual channel DDR. Additionally, to take full advantage of Intel Pentium 4 800 MHz FSB, the MCH needs to be designed to collaborate closely with the CPU, AGP, Memory, and the rest of the system.

Packaging Design

Dual channel DDR support requires nearly 18 percent more physical pins on the MCH packaging than a single channel DDR chipset. As a result, Intel paid special attention to the design of

the MCH package to improve electrical and signal integrity for maximum system performance and reliability while supporting the standard lower cost industry standard 4 layer Printed Circuit Board Assembly (PCBA.)

Design, Development, and Industry Support

Intel is the leading manufacturer of chipsets, with over 20 years' experience with innovative platform solutions. Intel designed the dual channel DDR memory interface architecture for the MCH used in 875P, 865G and 865PE chipsets to comply with the specifications developed by Intel and leading memory manufacturers. This ensures the highest reliability and optimal platform performance. To ensure availability of DDR 400 Memory, Intel worked closely with major memory suppliers on the specification and qualification of the memory module DIMMs. Intel's own chipset platform validation and compliance testing assures that this new memory enables awesome performance and wide interoperability on Intel 875P, 865G, and 865PE chipset-based platforms.



Figure 5: Dual channel DDR support packaging design challenges

Competitive Advantage

The Intel 875P chipset is ideal for entry-level workstations and high-end desktops. It is the first Intel® chipset to support a new performance enhancement feature called Performance Acceleration Technology (PAT) for even higher platform performance. This technology was developed using Intel's advanced design, manufacturing, and testing processes.

A system based on an Intel 875P chipset will out-perform other Intel based entry-level workstation and high-end desktop platform solutions with exact same processor, memory, and peripherals. PAT delivers additional system-level performance by optimizing memory access between the processor and system memory on platforms configured with 800 MHz front side bus and DDR400 system memory. Figure 6 illustrates the performance of 875P with 865G using the same configuration as compared to 865PE with lower speed CPU.

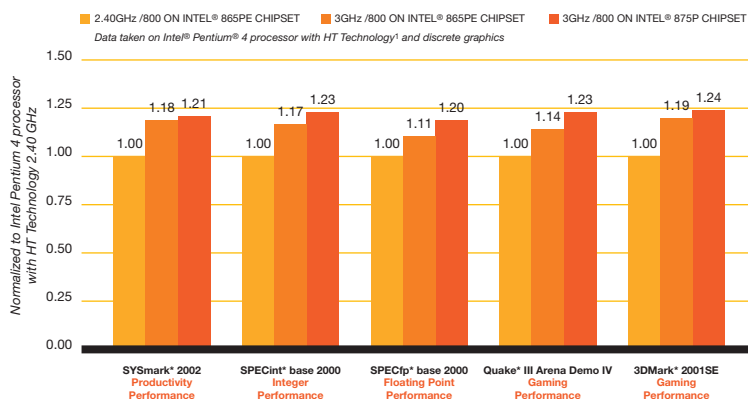


Figure 6: Performance of the Intel® 875 chipset compared to the Intel® 865PM chipset

Benchmark Configuration

Source: Intel® Configuration: Intel® Pentium® 4 Processor with HT Technology 2.40 GHz and Intel® 865G Chipset—Intel® 865PE Desktop Board, 512 MB DDR400; Intel® Pentium® 4 Processor with HT Technology 3 GHz and Intel® 865G Chipset—Intel® 865PE Desktop Board, 512 MB DDR400; Intel® Pentium® 4 Processor with HT Technology 3 GHz and Intel® 875P Chipset—Intel® 875P Desktop Board, 512 MB DDR400; All Platforms—ATI® Radeon® 9700 Pro AGP 8X, Graphics Driver 6166, Microsoft® Default UDMA-5, Intel® Chipset Software Installation Utility 5.00.1012, IBM® 80GB 120GXP IC35L080AVVA07-0 ATA-100 Hard Drive; Intel® C & FORTRAN compilers 7.0 for SPEC, DirectX® 8.1, Windows® XP Build 2600 SP1, 100 Mbps Intel® Pro/100+ Management PCI LAN Card. Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel® products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

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¹ Hyper-Threading Technology requires a computer system with an Intel® Pentium® 4 processor supporting HT Technology and a HT Technology enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. See <http://www.intel.info/hyperthreading/> for more information including details on which processors support HT Technology.

² The Intel® 865P chipset supports dual channel memory at DDR333 only.

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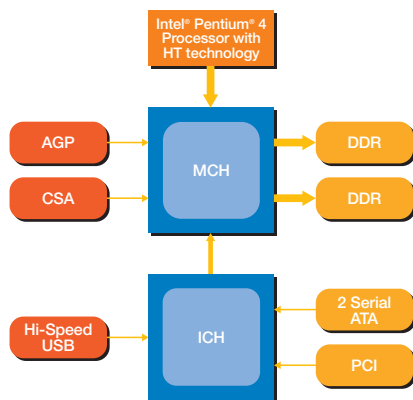


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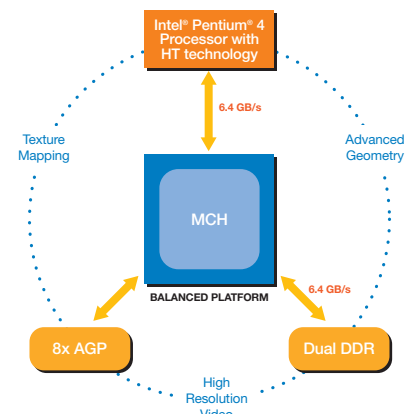


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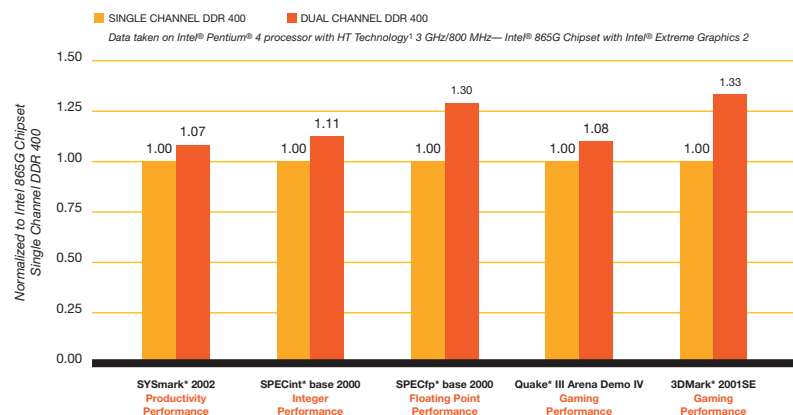


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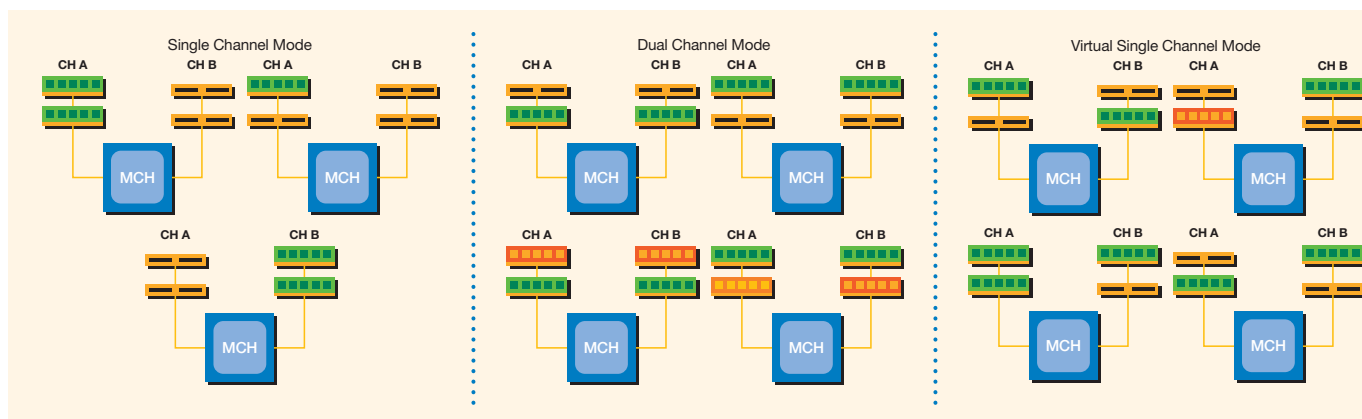


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